

EXHIBIT 7

BEK TEK LLC
Forensic Audio/Video/Image Consultants

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To: Steven E. Danekas, Esq.
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Re: ***JON BATTs, Plaintiff, v. REMINGTON ARMS COMPANY, LLC, Defendant.***
United States District Court, Western District of Texas, Waco Division
NO: WA:17-CV-00346-RP

Laboratory Number: 1902120

Specimen received: February 13, 2019 [from Mr. Lance Sloves (Computer Forensics Services, Inc.; Dallas, TX)]

Q1 One Micro Center USB3.0 32GB thumb drive, unmarked. Manufacturer's designations "1827" printed on the male port of the thumb drive and "511-180604112" printed on a label affixed to the circuit board and visible through the transparent housing.

Requested examinations:

BEK TEK LLC was initially requested to conduct an examination of a forensic image file of the evidentiary microSD memory card, which was produced by Mr. Lance Sloves of Computer Forensics Services, Inc. (Dallas, TX) and provided to BEK TEK LLC on specimen Q1. The requested examinations generally entailed (1) the analyses of two (2) video/audio recordings which had previously been provided to defense counsel and were alleged to be contained on the evidentiary microSD card and (2) the possible identification and recovery of other video/audio recordings related to the incident.

Once these initial requests were completed, including the export of two (2) existing video/audio MP4 files and the recovery of a previously-existing/deleted MP4 file related to the incident, the following additional requests were made of one or more of the exported/recovered MP4 files:

1. Still image extractions of designated portions (set forth in the sections below);
2. Still image enhancements of designated portions (set forth in the sections below);
3. Direct audio files of designated portions (set forth in the sections below);
4. Direct video/direct audio files of designated portions (set forth in the sections below);

5. Enhanced audio files of designated portions (set forth in the sections below);
6. Direct video/enhanced audio files of designated portions (set forth in the sections below);
7. A time-aligned, compiled direct video/direct audio file of the last two (2) MP4 files chronologically; and
8. An analysis of a designated portion in the third of the three (3) MP4 files chronologically, in an effort to determine the number of shells placed into an ammunition box by an individual.

Examinations of specimen Q1:

Specimen Q1 was found to contain a password-protected “7z” file named “IT001_SDCard.7z”, which itself was represented to BEK TEK LLC as containing a forensic image of the evidentiary microSD card, produced by Mr. Sloves. The following hash values were computed of “IT001_SDCard.7z” as it resided on specimen Q1:

- MD5: 45343FAD0F4B44CF9B127FCC8C03B4A9
- SHA-1: 143B4034BAA32D59AA1D41E5685407392732342
- SHA-256: E7153D4A355155364B153C6119231D4D1B103C2DC22D0DCB694FAC295D0A0F3B

“IT001_SDCard.7z” was copied to a laboratory 64GB USB thumb drive, and MD5, SHA-1, and SHA-256 hash values were computed for the copied file, which matched those hash values above, thereby verifying the copying process. All further examinations were conducted using this copied “IT001_SDCard.7z” file.

The contents of “IT001_SDCard.7z” were extracted using “7Zip” software along with the password provided by Mr. Sloves via email on February 12, 2019. The extracted contents were as follows, with the “IT001_SDCard.001” through “IT001_SDCard.016” files representing segments of a forensic image:

| Name | Type | Size | Date created | Date modified |
|----------------------|-----------------------------|--------------|--------------------|--------------------|
| IT001_SDCard.001 | Universal Extractor Archive | 2,048,000 KB | 4/10/2019 11:35 AM | 2/12/2019 11:47 AM |
| IT001_SDCard.001.txt | Text Document | 2 KB | 4/10/2019 11:36 AM | 2/12/2019 12:22 PM |
| IT001_SDCard.002 | 002 File | 2,048,000 KB | 4/10/2019 11:36 AM | 2/12/2019 11:49 AM |
| IT001_SDCard.003 | 003 File | 2,048,000 KB | 4/10/2019 11:37 AM | 2/12/2019 11:51 AM |
| IT001_SDCard.004 | 004 File | 2,048,000 KB | 4/10/2019 11:38 AM | 2/12/2019 11:53 AM |
| IT001_SDCard.005 | 005 File | 2,048,000 KB | 4/10/2019 11:39 AM | 2/12/2019 11:55 AM |
| IT001_SDCard.006 | 006 File | 2,048,000 KB | 4/10/2019 11:40 AM | 2/12/2019 11:57 AM |
| IT001_SDCard.007 | 007 File | 2,048,000 KB | 4/10/2019 11:42 AM | 2/12/2019 11:59 AM |
| IT001_SDCard.008 | 008 File | 2,048,000 KB | 4/10/2019 11:43 AM | 2/12/2019 12:01 PM |
| IT001_SDCard.009 | 009 File | 2,048,000 KB | 4/10/2019 11:44 AM | 2/12/2019 12:03 PM |
| IT001_SDCard.010 | 010 File | 2,048,000 KB | 4/10/2019 11:45 AM | 2/12/2019 12:05 PM |
| IT001_SDCard.011 | 011 File | 2,048,000 KB | 4/10/2019 11:46 AM | 2/12/2019 12:07 PM |
| IT001_SDCard.012 | 012 File | 2,048,000 KB | 4/10/2019 11:47 AM | 2/12/2019 12:09 PM |
| IT001_SDCard.013 | 013 File | 2,048,000 KB | 4/10/2019 11:49 AM | 2/12/2019 12:11 PM |
| IT001_SDCard.014 | 014 File | 2,048,000 KB | 4/10/2019 11:50 AM | 2/12/2019 12:13 PM |
| IT001_SDCard.015 | 015 File | 2,048,000 KB | 4/10/2019 11:51 AM | 2/12/2019 12:15 PM |
| IT001_SDCard.016 | 016 File | 228,352 KB | 4/10/2019 11:52 AM | 2/12/2019 12:15 PM |

Figure 1

“IT001_SDCard.001” was imported into a case within X-Ways Forensics (version 19.6) software, which opened the entire forensic image comprised of the “IT001_SDCard.001” through “IT001_SDCard.016” file segments. One partition was indicated within the forensic image, as shown below:

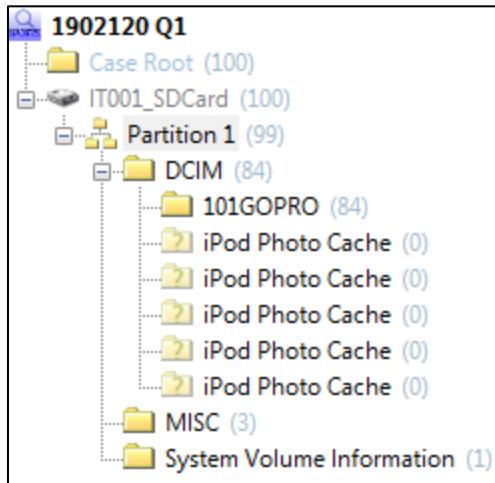


Figure 2

The “101GOPRO” folder was found to contain a series of existing and previously-existing/deleted “.MP4” files (MPEG-4 multimedia files), “.LRV” files (“Low Resolution Video” files), and “.THM” files (thumbnail image files). The “.LRV” and “.THM” files are written in conjunction with the primary “.MP4” files recorded by the GoPro device; more information regarding the “.LRV” and “.THM” files can be found at the following GoPro Help website: https://gopro.com/help/articles/Question_Answer/What-are-thm-and-lrv-files. From these existing/Previously-existing files, the following were identified as being the pertinent files related to the present matter (table is arranged in chronological order by created date/time):

| FILE | STATUS | CREATED | MODIFIED | ACCESSED |
|--------------|------------------------|------------------------|------------------------|------------|
| GOPR5586.THM | Existing | 11/18/2015 12:24:53 | 11/18/2015 12:24:52 | 02/07/2016 |
| GOPR5586.LRV | Existing | 11/18/2015 12:24:53 | 11/18/2015 12:27:34 | 02/07/2016 |
| GOPR5586.MP4 | Existing | 11/18/2015 12:24:53 | 11/18/2015 12:27:34 | 02/07/2016 |
| ?OPR5587.MP4 | Previously existing | 11/18/2015 12:36:19 | 11/18/2015 12:45:16 | 12/12/2015 |
| ?OPR5587.THM | Previously existing | 11/18/2015 12:36:20 | 11/18/2015 12:36:20 | 12/12/2015 |
| ?OPR5587.LRV | Previously existing | 11/18/2015 12:36:20 | 11/18/2015 12:45:16 | 12/12/2015 |
| GOPR5588.LRV | Existing | 11/18/2015 12:45:18 | 11/18/2015 12:50:20 | 12/12/2015 |
| GOPR5588.MP4 | Existing | 11/18/2015 12:45:18 | 11/18/2015 12:50:20 | 02/07/2016 |
| GOPR5588.THM | Existing | 11/18/2015 12:45:19 | 11/18/2015 12:45:18 | 12/12/2015 |

Table 1

These nine (9) files correspond to three (3) separate MP4 video/audio recordings made using the GoPro device, the second of which ("?OPR5587.MP4") was deleted from the evidentiary microSD card along with its corresponding ".LRV" and ".THM" files on or after "12/12/2015". Following the naming convention and numbering of the existing "GOPR5586.MP4" and "GOPR5588.MP4" files, the original file name for the deleted MP4 file was "GOPR5587.MP4", and "GOPR5587.LRV" and "GOPR5587.THM" for the corresponding files. The "?" at the beginning of the previously-existing file names as viewed in X-Ways Forensics software indicates that the first character of the file name was modified during the deletion process.

Using the "Recover/Copy" function of the X-Ways Forensics software, the nine (9) files in Table 1 were extracted from the forensic image and saved to a laboratory computer. MD5, SHA-1, and SHA-256 hash values were computed for the extracted "GOPR5586" and "GOPR5588" files using "jackson" software, and MD5 and SHA-1 hash values were computed for the extracted "?OPR5587" files using FTK Imager software (version 4.1.1.1). These hash values are provided in Exhibit 1 which is attached to this Laboratory Report.

While playback of the extracted "GOPR5586.MP4" and "GOPR5588.MP4" was successful, attempts to play back the extracted "?OPR5587.MP4" file in Windows Media Player, VLC Media Player, and FFMPEG software were unsuccessful, indicating that the recovery process within X-Ways Forensics software was unsuccessful.

Using the "Concatenate" tool within HxD software (version 2.0.0.0), the "IT001_SDCard.001" through "IT001_SDCard.016" file segments were concatenated in numerical order into a single file named "IT001_SDCard (concatenated).img". This file was then opened in the following two (2) programs designed to scan a forensic image file and recover files of specified types: KlenNet Carver software (build 735) and GoPro Recovery software (V1.84). In the KlenNet Carver software, "MP4" was set as the file type to scan for and recover, while the GoPro Recovery software is specifically designed to scan memory cards or forensic image files of memory cards used in GoPro devices and recover ".MP4", ".LRV", and ".THM" files. From these two (2) programs, the following files, corresponding to the previously-existing "GOPR5587.MP4" file, were recovered from "IT001_SDCard (concatenated).img" (their MD5, SHA-1, and SHA-256 hash values are provided in Exhibit 2):

| PROGRAM | FILE |
|----------------|-----------------|
| KlenNet Carver | "000046.mp4" |
| GoPro Recovery | "recover_7.mp4" |

Table 2

From visual reviews of playback of these two (2) files and preliminary frame analyses/comparisons of the beginnings of the files in Amped FIVE software (revision 13609), it was determined that both of the files feature partially-corrupted video frames, with the corruptions occurring more frequently within the KlenNet Carver "000046.mp4" file. Additionally, the frame analyses/comparisons in Amped FIVE software revealed that the GoPro Recovery "recover_7.mp4" file contains additional video frames at the very beginning which are not present in the KlenNet Carver "000046.mp4" file. For these reasons, "recover_7.mp4" was used for the remainder of the examinations relating to the deleted "GOPR5587.MP4" file.

"GOPR5586.MP4", "recover_7.mp4", and "GOPR5588.MP4" contain embedded "Creation time" and "Modification time" values within the MP4 file structure, which are stored in the

Hierarchical File System (HFS) date/time format (that is, the number of seconds that have elapsed since midnight, January 1, 1904, encoded as a 32-bit or 4-byte integer value). These “Creation time” and “Modification time” values relate to individual components or “atoms” within the MP4 files and not necessarily to the files in their entirety. These values are separate from the operating system created, modified, and accessed values seen in Table 1. Below is a summary of the operating system created and modified values and the “Creation time” and “Modification time” values for “GOPR5586.MP4”, “recover_7.mp4”, and “GOPR5588.MP4” (the operating system values for “recover_7.mp4” are taken from the “?OPR5587.MP4” values in Table 1):

| FILE | OPERATING SYSTEM | | | EMBEDDED | |
|---------------|------------------------|------------------------|--|------------------------|---------------------|
| | CREATED | MODIFIED | | CREATION TIME | MODIFICATION TIME |
| GOPR5586.MP4 | 11/18/2015 12:24:53 | 11/18/2015 12:27:34 | | 11/18/2015 12:24:53 | 11/18/2015 12:24:53 |
| recover_7.mp4 | 11/18/2015 12:36:19 | 11/18/2015 12:45:16 | | 11/18/2015 12:36:19 | 11/18/2015 12:36:19 |
| GOPR5588.MP4 | 11/18/2015 12:45:18 | 11/18/2015 12:50:20 | | 11/18/2015 12:45:18 | 11/18/2015 12:45:18 |

Table 3

It is noted that the embedded “Creation time” and “Modification time” values are the same within each file and that these values correspond directly with the operating system created time. Additionally, the calculated time differentials between the operating system modified and created times approximately match the actual lengths of the MP4 files, indicating that the operating system created values are the dates/times that the recordings began and the modified values are the dates/times that the recordings ended. A comparison of these calculated time differentials (in “minutes:seconds”, inclusive of both the start and end seconds) and recording lengths (in frames and “minutes:seconds.milliseconds” at 59.94 frames per second) for “GOPR5586.MP4”, “recover_7.mp4”, and “GOPR5588.MP4” follows:

| FILE | OPERATING SYSTEM | | | LENGTH | |
|---------------|------------------------|------------------------|--------------|--------|-----------|
| | CREATED | MODIFIED | DIFFERENTIAL | FRAMES | TIME |
| GOPR5586.MP4 | 11/18/2015 12:24:53 | 11/18/2015 12:27:34 | 02:42 | 9,644 | 02:40.894 |
| recover_7.mp4 | 11/18/2015 12:36:19 | 11/18/2015 12:45:16 | 08:58 | 32,161 | 08:56.553 |
| GOPR5588.MP4 | 11/18/2015 12:45:18 | 11/18/2015 12:50:20 | 05:03 | 18,077 | 05:01.585 |

Table 4

Based on the start time of “recover_7.mp4” (“11/18/2015 12:36:19”) and its actual length (32,161 frames at 59.94 frames per second, or 08:56.553), both given in Table 4, the calculated end time of “recover_7.mp4” is approximately “11/18/2015 12:45:15.553”. Therefore, the approximate time difference between the end of “recover_7.mp4” and the start of “GOPR5588.MP4” (“11/18/2015 12:45:18” from Table 4) is 2.447 seconds, or 147 frames at 59.94 frames per second as rounded up to the nearest frame. Because the operating system created times/embedded “Creation time” values for “recover_7.mp4” and “GOPR5588.MP4” are

limited to the seconds value, the approximate time difference above has an accuracy of ± 1 second (i.e., 2.447 ± 1 seconds).

Based on the analyses conducted of the forensic image file of the evidentiary microSD card described above, the following conclusions were drawn:

1. Three (3) MP4 video/audio recordings were originally made on “11/18/2015” and had sequentially-numbered file names of “GOPR5586.MP4”, “GOPR5587.MP4”, and “GOPR5588.MP4”.
2. The file “GOPR5587.MP4” and its corresponding “.LRV” (“Low Resolution Video”) and “.THM” (thumbnail image) files were subsequently deleted from the evidentiary microSD card on or after “12/12/2015”.
3. The approximate length of time that was not recorded between the end of “GOPR5587.MP4” and the start of “GOPR5588.MP4” is 2.447 ± 1 seconds.

Video/still image processing examinations (“GOPR5586.MP4”):

Using Amped FIVE software (revision 13609), image processing examinations were conducted of designated portions of “GOPR5586.MP4”, with output Portable Network Graphics (PNG) images produced, as follows (times are given in a “minutes:seconds.milliseconds” format, unless otherwise noted):

1. Frames 3837 (01:04.014)→3886 (01:04.831): cropped around the ammunition box on the counter; enhanced (including Frame Averaging); re-sized to 100x-enlargement (10x on each dimension) using Nearest Neighbor method; and result exported as “GOPR5586 (01_04) (ammunition box) (enhanced, cropped, 100x-enlarged) (1).png” into a folder named “GOPR5586 (01_04) (ammunition box)”.
2. Same as “1.” but with Bicubic interpolation method used for the re-size process. Result exported as “GOPR5586 (01_04) (ammunition box) (enhanced, cropped, 100x-enlarged) (2).png” into the folder named “GOPR5586 (01_04) (ammunition box)”.
3. Frames 9216 (02:33.754)→9355 (02:36.073): cropped around the ammunition box on the counter; enhanced (including Frame Averaging); re-sized to 100x-enlargement (10x on each dimension) using Nearest Neighbor method; and result exported as “GOPR5586 (02_33-02_36) (ammunition box) (enhanced, cropped, 100x-enlarged) (1).png” into a folder named “GOPR5586 (02_33-02_36) (ammunition box)”.
4. Same as “3.” but with Bicubic interpolation method used for the re-size process. Result exported as “GOPR5586 (02_33-02_36) (ammunition box) (enhanced, cropped, 100x-enlarged) (2).png” into the folder named “GOPR5586 (02_33-02_36) (ammunition box)”.

The folders above were themselves placed into a folder named “GOPR5586 (stills)”.

Video/still image processing examinations (“recover_7.mp4”):

Using Amped FIVE software (revision 13609), the following frame/time ranges of “recover_7.mp4” were exported as separate PNG image sequences with no processing applied to them (times are given in a “minutes:seconds.milliseconds” format, unless otherwise noted):

1. Frames 0 (00:00.000)→8932 (02:29.016) as “0000.png” through “8932.png”, into a folder named “recover_7 (recovered 5587) (00_00-02_29)”;
2. Frames 10668 (02:57.978)→11689 (03:15.011) as “10668.png” through “11689.png” into a folder named “recover_7 (recovered 5587) (02_58-03_15)”;

3. Frames 13485 (03:44.975)→14985 (04:10.000) as “13485.png” through “14985.png” into a folder named “recover_7 (recovered 5587) (03_45-04_10)”; and
4. Frames 30389 (08:26.990)→32160 (08:56.536) (last frame) as “30389.png” through “32160.png” into a folder named “recover_7 (recovered 5587) (08_27-08_56)”.

The folders above were themselves placed into a folder named “recover_7 (recovered 5587) (stills)”.

Using Amped FIVE software (revision 13609), image processing examinations were conducted of designated portions of “recover_7.mp4”, with PNG images produced, as follows (times are given in a “minutes:seconds.milliseconds” format, unless otherwise noted):

1. Frames 305 (00:05.088)→357 (00:05.956): cropped the around ammunition box and other items on the counter; enhanced (including Frame Averaging); re-sized to 64x-enlargement (8x on each dimension) using Nearest Neighbor method; and result exported as “recover_7 (recovered 5587) (00_05) (ammunition box) (enhanced, cropped, 64x-enlarged) (1).png” into a folder named “recover_7 (00_05) (ammunition box)”.
2. Same as “1.” but with Bicubic interpolation method used for the re-size process. Result exported as “recover_7 (00_05) (ammunition box) (enhanced, cropped, 64x-enlarged) (2).png” into the folder named “recover_7 (recovered 5587) (00_05) (ammunition box)”.
3. Frames 1476 (00:24.625)→1480 (00:24.691): cropped around the rifle’s muzzle; enhanced; re-sized to 36x-enlargement (6x on each dimension) using Nearest Neighbor method; and results exported as “recover_7 (00_24, 1476) (muzzle) (enhanced, cropped, 36x-enlarged) (1).png” through “recover_7 (00_24, 1480) (muzzle) (enhanced, cropped, 36x-enlarged) (1).png” into a folder named “recover_7 (recovered 5587) (00_24) (muzzle)”.
4. Same as “3.” but with Bicubic interpolation method used for the re-size process. Results exported as “recover_7 (00_24, 1476) (muzzle) (enhanced, cropped, 36x-enlarged) (2).png” through “recover_7 (00_24, 1480) (muzzle) (enhanced, cropped, 36x-enlarged) (2).png” into the folder named “recover_7 (recovered 5587) (00_24) (muzzle)”.

The folders above were themselves placed into the folder named “recover_7 (recovered 5587) (stills)”.

Video/still image processing examinations (“GOPR5588.MP4”):

Using Amped FIVE software (revision 13609), the following frame/time ranges of “GOPR5588.MP4” were exported as separate PNG image sequences with no processing applied to them (times are given in a “minutes:seconds.milliseconds” format, unless otherwise noted):

1. Frames 299 (00:04.988)→480 (00:08.008) as “299.png” through “480.png” into a folder named “GOPR5588 (00_05-00_08)”;
2. Frames 1738 (00:28.996)→2518 (00:42.009) as “1738.png” through “2518.png” into a folder named “GOPR5588 (00_29-00_42)”;
3. Frames 7072 (01:57.985)→11089 (03:05.001) as “07072.png” through “11089.png” into a folder named “GOPR5588 (01_58-03_05)”;
4. Frames 16663 (04:37.994)→18076 (05:01.568) (last frame) as “16663.png” through “18076.png” into a folder named “GOPR5588 (04_38-05_01)”.

The folders above were themselves placed into a folder named “GOPR5588 (stills)”.

Using Amped FIVE software (revision 13609), image processing examinations were conducted of designated portions of “GOPR5588.MP4”, with PNG images produced, as follows (times are given in a “minutes:seconds.milliseconds” format, unless otherwise noted):

1. Frame 688 (00:11.478): cropped around the pen(s) in the pocket of the individual’s left sleeve; enhanced; re-sized to 36x-enlarge (6x on each dimension) using Nearest Neighbor method; and result exported as “GOPR5588 (00_11) (pen) (enhanced, cropped, 36x-enlarge) (1).png” into a folder named “GOPR5588 (00_11) (pen)”.
2. Same as “1.” but with Bicubic interpolation method used for the re-size process. Result exported as “GOPR5588 (00_11) (pen) (enhanced, cropped, 36x-enlarge) (2).png” into the folder named “GOPR5588 (00_11) (pen)”.
3. Frames 2391 (00:39.890)→2424 (00:40.440): cropped around the ammunition box on the counter; enhanced (including Frame Averaging); re-sized to 36x-enlarge (6x on each dimension) using Nearest Neighbor method; and result exported as “GOPR5588 (00_39-00_40) (ammunition box) (enhanced, cropped, 36x-enlarge) (1).png” into a folder named “GOPR5588 (00_39-00_40) (ammunition box)”.
4. Same as “3.” but with Bicubic interpolation method used for the re-size process. Result exported as “GOPR5588 (00_39-00_40) (ammunition box) (enhanced, cropped, 36x-enlarge) (2).png” into the folder named “GOPR5588 (00_39-00_40) (ammunition box)”.
5. Frames 7136 (01:59.052)→7255 (02:01.038): cropped around the shells on the counter; enhanced; re-sized to 36x-enlarge (6x on each dimension) using Nearest Neighbor method; and results exported as “GOPR5588 (01_59-02_01, 7136) (shells on counter) (enhanced, cropped, 36x-enlarge) (1).png” through “GOPR5588 (01_59-02_01, 7255) (shells on counter) (enhanced, cropped, 36x-enlarge) (1).png” into a folder named “GOPR5588 (01_59-02_01) (shells on counter) (1)”.
6. Same as “5.” but with Bicubic interpolation method used for the re-size process. Results exported as “GOPR5588 (01_59-02_01, 7136) (shells on counter) (enhanced, cropped, 36x-enlarge) (2).png” through “GOPR5588 (01_59-02_01, 7255) (shells on counter) (enhanced, cropped, 36x-enlarge) (2).png” into a folder named “GOPR5588 (01_59-02_01) (shells on counter) (1)”.
7. Frames 7288 (02:01.588)→7591 (02:06.6438): cropped around the ammunition box and the individual’s hands; enhanced; re-sized to 25x-enlarge (5x on each dimension) using Nearest Neighbor method; and results exported as “GOPR5588 (02_01-02_06, 7288) (shells into box) (enhanced, cropped, 25x-enlarge) (1).png” through “GOPR5588 (02_01-02_06, 7591) (shells into box) (enhanced, cropped, 25x-enlarge) (1).png” into folder named “GOPR5588 (02_01-02_06) (shells into box) (1)”.
8. Same as “7.” but with Bicubic interpolation method used for the re-size process. Results exported as “GOPR5588 (02_01-02_06, 7288) (shells into box) (enhanced, cropped, 25x-enlarge) (2).png” through “GOPR5588 (02_01-02_06, 7591) (shells into box) (enhanced, cropped, 25x-enlarge) (2).png” into a folder named “GOPR5588 (02_01-02_06) (shells into box) (2)”.
9. Frames 8435 (02:20.724)→8518 (02:22.109): enhanced and results exported as “GOPR5588 (02_20-02_22, 8435) (inside bag) (enhanced).png” through “GOPR5588 (02_20-02_22, 8518) (inside bag) (enhanced).png” into a folder named “GOPR5588 (02_20-02_22) (inside bag)”.
10. Frame 16840 (04:40.947): cropped around pen(s) in the pocket of the individual’s left sleeve; enhanced; rotated (90° CCW); re-sized to 16x-enlarge (4x on each dimension) using Nearest Neighbor method; and result exported as “GOPR5588 (04_40)

(pen) (enhanced, cropped, 16x-enlarged) (1).png" into a folder named "GOPR5588 (04_40) (pen)".

11. Same as "10." but with Bicubic interpolation method used for the re-size process.

Result exported as "GOPR5588 (00_11) (pen) (enhanced, cropped, 36x-enlarged) (2).png" into the folder named "GOPR5588 (00_11) (pen)".

12. Frames 17168 (04:46.419)→17497 (04:51.908): enhanced (including Frame Averaging and result exported as "GOPR5588 (04_46-04_51) (inside bag) (enhanced).png" into a folder named "GOPR5588 (04_46-04_51) (inside bag)".

13. Frames 17760 (04:56.296)→17851 (04:57.814): enhanced and results exported as "GOPR5588 (04_56-04_57, 17760) (inside bag) (enhanced).png" through "GOPR5588 (04_56-04_57, 17851) (inside bag) (enhanced).png" into a folder named "GOPR5588 (04_56-04_57) (inside bag)".

14. Frames 17968 (04:59.766)→18076 (05:01.568): enhanced and results exported as "GOPR5588 (04_59-05_01, 17968) (bag on floor) (enhanced).png" through "GOPR5588 (04_59-05_01, 18076) (bag on floor) (enhanced).png" into a folder named "GOPR5588 (04_59-05_01) (bag on floor)".

The folders above were themselves placed into a folder named "GOPR5588 (stills)".

Video/audio extractions of designated portions ("recover_7.mp4"):

Using FFMPEG software (version 4.1.3), the following designated portions of "recover_7.mp4" were extracted as separate direct video/direct audio MP4 files (with no re-encoding of the recorded video and audio) and uncompressed audio-only WAV files (times are given in a "minutes:seconds" format, unless otherwise noted):

1. 00:11→00:14 [as "recover_7 (00_11-00_14) (direct video-direct audio).mp4" and "recover_7 (00_11-00_14) (direct audio, PCM).wav"];
2. 00:20→01:11 [as "recover_7 (00_20-01_11) (direct video-direct audio).mp4" and "recover_7 (00_20-01_11) (direct audio, PCM).wav"];
3. 08:08→08:11 [as "recover_7 (08_08-08_11) (direct video-direct audio).mp4" and "recover_7 (08_08-08_11) (direct audio, PCM).wav"]; and
4. 08:48→end [as "recover_7 (08_48-end) (direct video-direct audio).mp4" and "recover_7 (08_48-end) (direct audio, PCM).wav"].

All these MP4 and WAV files were saved into a folder named "recover_7 (recovered 5587) (audio-video files)".

Audio enhancement examinations ("recover_7.mp4"):

Using FFMPEG software (version 4.1.3), the following designated portions of "recover_7.mp4" were extracted as separate direct video-only MP4 files (with no re-encoding of the recorded video) and uncompressed audio-only WAV files (times are given in a "minutes:seconds" format): 02:25→02:58, 03:10→03:19, and 03:35→03:51.

Using Sound Forge Pro (version 11.0) and iZotope RX7 Advanced software, audio enhancements of the three (3) uncompressed audio-only WAV files above were conducted and the results were saved as the following uncompressed audio-only WAV files, respectively:

1. "recover_7 (02_25-02_58) (enhanced audio).wav";
2. "recover_7 (03_10-03_19) (enhanced audio).wav"; and

3. “recover_7 (03_35-03_50) (enhanced audio).wav”.

These WAV files were then multiplexed with lossless H.264 video versions of their corresponding direct video-only MP4 files and saved as separate direct video/enhanced audio files (in QuickTime MOV format):

4. “recover_7 (02_25-02_58) (direct video-enhanced audio).mov”;
5. “recover_7 (03_10-03_19) (direct video-enhanced audio).mov”; and
6. “recover_7 (03_35-03_50) (direct video-enhanced audio).mov”.

All these WAV and MOV files were saved into the folder named “recover_7 (recovered 5587) (audio-video files)”.

Video/audio extractions of designated portions (“GOPR5588.MP4”):

Using FFMPEG software (version 4.1.3), the following designated portions of “GOPR5588.MP4” were extracted as separate direct video/direct audio MP4 files (with no re-encoding of the recorded video and audio) and uncompressed audio-only WAV files (times are given in a “minutes:seconds” format, unless otherwise noted):

1. 00:00→00:11 [as “GOPR5588 (00_00-00_11) (direct video-direct audio).mp4” and “GOPR5588 (00_00-00_11) (direct audio, PCM).wav”]; and
2. 00:24→00:36 [as “GOPR5588 (00_24-00_36) (direct video-direct audio).mp4” and “GOPR5588 (00_24-00_36) (direct audio, PCM).wav”]

All these MP4 and WAV files were saved into a folder named “GOPR5588 (audio-video files)”.

Audio enhancement examinations (“GOPR5588.MP4”):

Using FFMPEG software (version 4.1.3), the following designated portions of “GOPR5588.MP4” were extracted as separate, overlapping direct video-only MP4 files (with no re-encoding of the recorded video) and uncompressed audio-only WAV files (times are given in a “minutes:seconds” format): 00:45→02:25 and 02:20→end.

Using Sound Forge Pro (version 11.0) and iZotope RX7 Advanced software, audio enhancements of the two (2) uncompressed audio-only WAV files above were conducted and the results were saved as the following uncompressed audio-only WAV files, respectively:

1. “GOPR5588 (00_45-02_25) (enhanced audio).wav”; and
2. “GOPR5588 (02_20-end) (enhanced audio).wav”.

These WAV files were then multiplexed with lossless H.264 video versions of their corresponding direct video-only MP4 files and saved as separate direct video/enhanced audio files (in QuickTime MOV format):

3. “GOPR5588 (00_45-02_25) (direct video-enhanced audio).mov”; and
4. “GOPR5588 (02_20-end) (direct video-enhanced audio).mov”.

All these WAV and MOV files were saved into the folder named “GOPR5588 (audio-video files)”.

Time-aligned compilation of “recover_7.mp4” and “GOPR5588.MP4”:

Using FFMPEG software (version 4.1.3), a video file containing only black-colored frames, having pixel dimensions of 1920 pixels wide by 1080 pixels high and a framerate of

59.94 frames per second, and having a length of 147 frames was created and saved as “black.mp4” (see the conclusions of the “Examinations of specimen Q1” above). “recover_7.mp4”, “black.mp4”, and “GOPR5588.MP4” were then concatenated into a separate, time-aligned compilation video/audio file named “1902120 Compilation of recover_7 & GOPR5588 (black video in-between).mp4” (lossless H.264 video encoding, with the original audio streams of “recover_7.mp4” and “GOPR5588.MP4” retained). “1902120 Compilation of recover_7 & GOPR5588 (black video in-between).mp4” was placed into a folder named “Time-aligned compilation of recover_7 & GOPR5588”.

Because the operating system created times/embedded “Creation time” values for “recover_7.mp4” and “GOPR5588.MP4” are limited to the seconds value, the time-alignment presented in “1902120 Compilation of recover_7 & GOPR5588 (black video in-between).mp4” has an accuracy of ± 1 second.

Examination of designated portion of “GOPR5588.MP4” (2:02→2:06):

Aural reviews, waveform analysis (that is, amplitude on the vertical axis vs. time on the horizontal), and spectrographic analysis (that is, frequency on the vertical axis vs. time on the horizontal vs. varying levels of grayscale for amplitude) were conducted of the recorded audio within the designated 02:02→02:06 portion of “GOPR5588.MP4”, in an attempt to ascertain how many shells were placed into the ammunition box (partially visible in the recorded video content) by the individual. These analyses revealed that there is a series of higher-amplitude, transient-like sounds during the designated portion, occurring at the following approximate times (“minutes:seconds.milliseconds”), roughly grouped into three (3) time regions:

1. Region 1 – 02:02.404;
2. Region 2 – 02:03.886, 02:03.967, and 02:04.093;
3. Region 3 – 02:05.301 and 02:05.395.

These transients generally correlate to the moments when the individual is seen placing shells into the ammunition box in the corresponding video content. The spectrographic analyses revealed that the events at 02:02.404, 02:03.967, 02:04.093, 02:05.301, and 02:05.395 exhibit greater energy across a broader range of frequencies than the event at 02:03.886.

Additionally, from reviews of the previously-described cropped/enhanced/enlarged image files in the “GOPR5588 (01_59-02_01) (shells on counter) (1)” and “GOPR5588 (01_59-02_01) (shells on counter) (2)” folders, which immediately precede this designated portion, it is evident that four (4) shells were present on the counter and picked up by the individual. In particular, see “GOPR5588 (01_59-02_01, 7233) (shells on counter) (enhanced, cropped, 36x-enlarged) (1).png” through “GOPR5588 (01_59-02_01, 7242) (shells on counter) (enhanced, cropped, 36x-enlarged) (1).png” and “GOPR5588 (01_59-02_01, 7233) (shells on counter) (enhanced, cropped, 36x-enlarged) (2).png” through “GOPR5588 (01_59-02_01, 7242) (shells on counter) (enhanced, cropped, 36x-enlarged) (2).png”. Reviews of the previously-described cropped/enhanced/enlarged image files in the “GOPR5588 (02_01-02_06) (shells into box) (1)” and “GOPR5588 (02_01-02_06) (shells into box) (2)” folders, which correspond directly with the designated portion of 02:02→02:06, were also conducted.

Given the visual confirmation that four (4) shells were present on the counter and picked up by the individual, the sounds occurring at 02:02.404 and 02:05.301/02:05.395 (collectively) each appear to correspond to the placing of one (1) shell each into the box; a single shell is visible in the individual’s hand preceding 02:02.404 but no shell is visible in the 02:05.301/02:05.395 portion. The multiple transient-like events in the 02:05.301/02:05.395

portion were likely caused by the shell striking the base of the box, bouncing up, and then striking the base of the box a second time, or possibly were the result of an unrelated acoustic event. The sounds from 02:03.886 through 02:04.093 would then correspond to the placing of the remaining two (2) shells into the box; visually, it appears that the individual uses both hands to place multiple shells into the box during this segment, with only one (1) shell being visible in the individual's hand during this process. Again, the multiple transient-like events from 02:03.886 through 02:04.093 were likely caused by the shells striking the base of the box, bouncing up, and then each striking the base of the box a second time, or possibly were the result of unrelated acoustic events.

The attached Exhibit 3 features a waveform display (in the top portion) and a spectrographic display (in the bottom portion) of the time range of 02:02→02:06 of “GOPR5588.MP4”. Arrows have been overlaid on the spectrogram to indicate the probable locations of the four (4) shells' initial strikes against the bottom of the ammunition box at 02:02.404, 02:03.967, 02:04.093, and 02:05.301.

USB thumb drives containing output files:

Three (3) PNY 64GB USB thumb drives were prepared, each containing the following output folders:

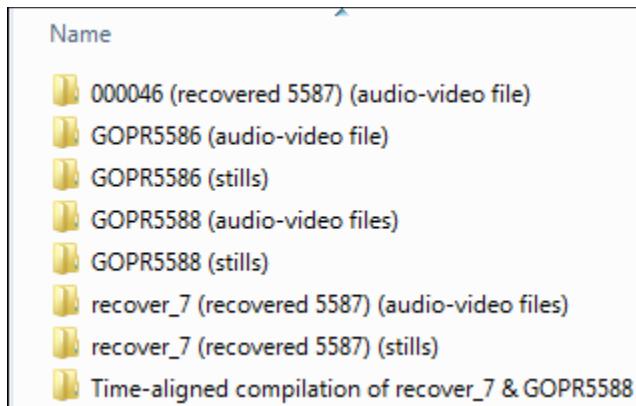


Figure 3

These folders contain the various output audio, video/audio, and image files (in sub-folders, as applicable) described in the sections above. The extracted/recovered “GOPR5586.MP4”, “recover_7.mp4”, and “GOPR5588.MP4” files were also copied into the “GOPR5586 (audio-video file)”, “recover_7 (recovered 5587) (audio-video files)”, and “GOPR5588 (audio-video file)” folders, respectively, and the Klennet Carver-recovered “000046.mp4” file was copied into the “000046 (recovered 5587) (audio-video file)” folder.

The thumb drives also include “TestFiles.exe” and “checksums.exf” files in their root directory, which can be utilized to confirm that no changes have been made to the files since they were originally written to the thumb drives. Running the “TestFiles.exe” file will initiate a verification process of the files contained on the thumb drive and will report the results once the process is completed.

The three (3) thumb drives were forwarded to your office on July 11, 2019, via Federal Express Priority Overnight service. It is BEK TEK LLC's understanding that one (1) of these

thumb drives will be attached to this Laboratory Report as Exhibit 4. Specimen Q1 will remain in BEK TEK LLC's possession until further advised.

Summary of conclusions:

Based on the analyses conducted of the forensic image of the evidentiary microSD card (as contained on specimen Q1) and of a designated portion (02:02→02:06) of "GOPR5588.MP4", the following conclusions were drawn:

1. Three (3) MP4 video/audio recordings were originally made on "11/18/2015" and had sequentially-numbered file names of "GOPR5586.MP4", "GOPR5587.MP4", and "GOPR5588.MP4".
2. The file "GOPR5587.MP4" and its corresponding ".LRV" ("Low Resolution Video") and ".THM" (thumbnail image) files were subsequently deleted from the evidentiary microSD card on or after "12/12/2015".
3. The approximate length of time that was not recorded between the end of "GOPR5587.MP4" and the start of "GOPR5588.MP4" is 2.447 ± 1 seconds.
4. Four (4) shells were placed into the ammunition box during the 02:02→02:06 portion of "GOPR5588.MP4", with the probable locations of the initial strikes of the shells against the bottom of the ammunition box occurring at 02:02.404, 02:03.967, 02:04.093, and 02:05.301.

Administrative:

The forensic examinations listed above were conducted by Douglas S. Lacey, whose curriculum vitae is attached as Exhibit 5. The listings of Mr. Lacey's expert testimony and peer-reviewed publications are included in Exhibit 5. BEK TEK LLC is being compensated at a rate of \$295.00 per hour, plus for actual expenses.



07/15/2019

BEK TEK LLC
Forensic Audio/Video/Image Consultants

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1902120

LABORATORY REPORT
DATED JULY 15, 2019

EXHIBIT 1

**Hash values for the
“Gopr5586.mp4”, “?opr5587.mp4”,
and “Gopr5588.mp4” files extracted
from the forensic image contained on
specimen Q1 using X-Ways Forensics
software**

1902120 Q1 GOPR5586 & GOPR5588 files checksum hash values.txt
 File name: GOPR5588.THM
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 11461 bytes
 MD5: ae96dd879648df3216a433f8ad5383e3
 SHA1: 1b8fb4045d55239bc006ef59b1325ea17b176592
 SHA256: 534fe67cc937cb78ee0dec7239d1cd6aa812bce66b8948c947492e6d4c76299f

File name: GOPR5586.LRV
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 16857041 bytes
 MD5: 5cfa51fde5168d361bdf4f4220a094a1
 SHA1: 3bc99112a4a7603cd094880448e0c1a3f0c977fa
 SHA256: a1ac55b61f951ff3bcafb0e0159a924cec8f8c14f5a405d546ad90a46dd567f8

File name: GOPR5586.MP4
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 506273208 bytes
 MD5: 1f1fbb3174bdcec066e366c8d6abaf9
 SHA1: 89bca89fa8c7512fc88eab96ecacf16c281dc1d1
 SHA256: f5c10b8b77f1b889a42059ca178a1c7639edcc8f701965b521c007af6e3bf3cd

File name: GOPR5586.THM
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 7466 bytes
 MD5: 91f5ca2ec69a4cb81a961a406e41cba6
 SHA1: 57ba990a18bb1f71f8cb22417d43210a2e20168c
 SHA256: 674193e969ba88b34d3b4f544190adbfe8c7bc60ad8116a368c38b25c5ca35c6

File name: GOPR5588.LRV
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 29971619 bytes
 MD5: fc828b02ff9de203d22c83c75a76c7d6
 SHA1: 05ea1474ea0753ce2e97a6199671fad992657d3e
 SHA256: 4d47f1d6efa8b9f92bb90714ef85580948247a3821ee34cf7e98764950e30f9a

File name: GOPR5588.MP4
 File path: D:\Cases\2019\1902120\Q1 (X-Ways Forensics case)\1902120
 Q1\IT001_SDCard, P1\DCIM\101GOPRO\
 File size: 947768345 bytes
 MD5: 5b3644fc822b5ab65cc3fb5e8c51dcd4
 SHA1: 365c6cb59de46749b55a43342390419e567636d5
 SHA256: 188d7a6cd0f7af646f9527727c2acd79f36be57bb8a4bc256ac98a08f3072904

| MD5 | SHA1 | FileNames |
|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4f54543e9b67ee2ba0df539b5eed6cba 819ebab21bf983bc1d5d0e5fd648077 7f65214ee238116fede7f800fd96a45d | 7a468e4dc357ee9b37bf27e85eadd9cd046766e1 962f62f65a2dc0bad21527e51174380360905f37 0ab10035439b4aa8868b1816141ada6d782a7597 | 101GOPRO\1902120 Q1 (X-Ways Forensics case)\1902120 Q1\IT001_SDCard, P1\DCIM\101GOPRO\? OPR5587.LRV 101GOPRO\1902120 Q1 (X-Ways Forensics case)\1902120 Q1\IT001_SDCard, P1\DCIM\101GOPRO\? OPR5587.MP4 101GOPRO\1902120 Q1 (X-Ways Forensics case)\1902120 Q1\IT001_SDCard, P1\DCIM\101GOPRO\? OPR5587.THM |

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LABORATORY REPORT
DATED JULY 15, 2019

EXHIBIT 2

**Hash values for the “000046.mp4” and
“recover_7.mp4” files, recovered from
the forensic image contained on
specimen Q1 using Klennet Carver
and GoPro Recovery software,
respectively**

1902120 000046.mp4.jacksum hash values.txt
File name: 000046.mp4
File path: D:\Cases\2019\1902120\Klennet Carver files\MP4\Damaged\
File size: 1610219520 bytes
MD5: 734874eaf73f2d8b6b931ab49a660a52
SHA1: af61bdc146307c921f9b2bb4371afafbc4d4cc80
SHA256: c0f7b8db5203994aace7a0a0bd2cb47b9caaf3002b32efc7411d5f657abcd3

File name: 1902120_recover_7.mp4 checksum hash values.txt
File path: recover_7.mp4
File size: D:\Cases\2019\1902120\GoPro Recovery files\
MD5: 1609695232 bytes
SHA1: 2b4f1a5a64240d815652f3c40a28b557
SHA256: ed9868440e4d51947ff51703752a36f123dc0937
SHA512: acfd69e2af95db3a7337ed79d96afcba28df84b540cdf20c9c43bd1da3c063b

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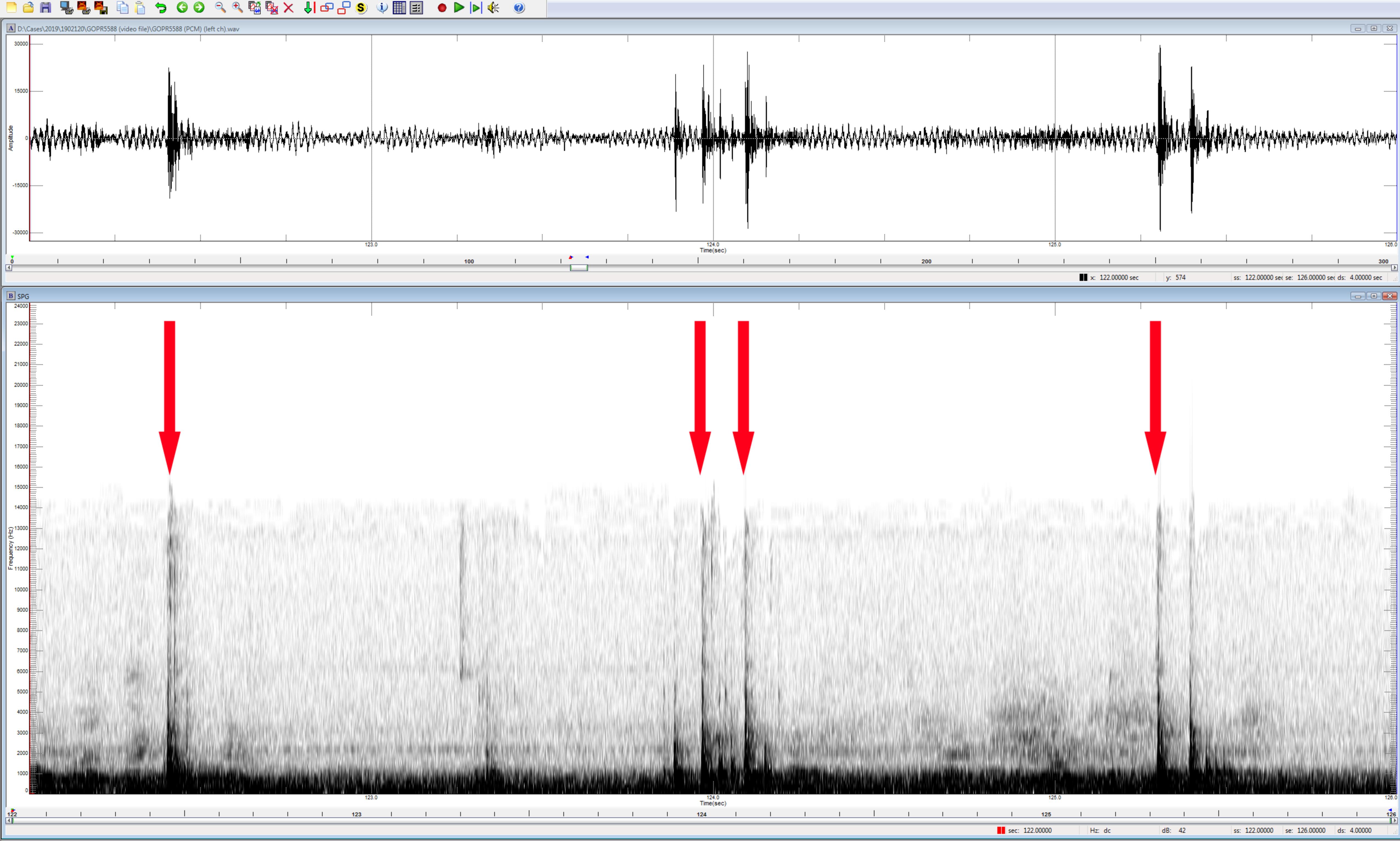
Bruce E. Koenig
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LABORATORY REPORT
DATED JULY 15, 2019

EXHIBIT 3

**Waveform display (top portion) and
spectrographic display (bottom
portion) of 02:02→02:06 of
“GOPR5588.MP4” [with arrows
indicating the probable locations of
the initial strikes of the four (4)
shells against the bottom of the
ammunition box]**



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LABORATORY REPORT
DATED JULY 15, 2019

EXHIBIT 4

**PNY 64GB USB thumb drive
containing the various output audio,
video/audio, and image files (in sub-
folders, as applicable) described in
the Laboratory Report**

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LABORATORY REPORT
DATED JULY 15, 2019

EXHIBIT 5

Curriculum Vitae for
Douglas S. Lacey

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Bruce E. Koenig
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CURRICULUM VITAE OF DOUGLAS S. LACEY

Professional Positions

August 2014 – Present **BEK TEK LLC (Stafford, Virginia).** Owner, private consultant, examiner, and researcher. Conducts forensic examinations of audio and video media (analog and digital) and digital images, including authentication of recordings/images, intelligibility/visual enhancement, identification/classification of non-voice signals, voice comparison, digital data retrieval/analysis, metadata analysis, and other related examinations. Presents expert testimony and assists attorneys with preparing for cross-examination of opposing experts. Evaluates appropriate recording and analysis equipment. Conducts research in forensic audio/video/image analysis related fields and authors/co-authors peer-reviewed papers and other publications.

October 1999 – July 2014 **DL Technology LLC (Fredericksburg, Virginia).** Private consultant, examiner, and researcher for BEK TEK LLC (Clifton, Virginia). Conducted forensic examinations of audio and video media (analog and digital) and digital images, including authentication of recordings/images, intelligibility/visual enhancement, identification/classification of non-voice signals, voice comparison, digital data retrieval/analysis, metadata analysis, and other related examinations. Presented expert testimony and assisted attorneys with preparing for cross-examination of opposing experts. Evaluated appropriate recording and analysis equipment. Conducted research in forensic audio/video/image analysis related fields and authored/co-authored peer-reviewed papers and other publications. LLC registered in July 2003 and amended in August 2014.

September 1996 – June 2003 **Federal Bureau of Investigation (FBI) (Quantico, Virginia).** Electronics Engineer / Forensic Examiner. Conducted examinations of audio recordings produced or collected by federal, state, local, and foreign law enforcement and judicial agencies. These examinations included authentication of recordings, intelligibility enhancement, identification and classification of non-voice signals, digital data retrieval/analysis, and other related examinations. Additional duties included the presentation of expert testimony in criminal matters, support to FBI field offices and other law enforcement agencies regarding technical assistance pertaining to audio recordings, and training of FBI personnel in the analysis of proprietary digital recording devices. Held a full-field, TOP SECRET clearance for the entirety of the employment.

Certifications

Certified Forensic Video Examiner (IAI, August 2014 to August 2019)

Certified Cyber Forensics Professional (CCFPSM) [(ISC)², July 2013 to July 2019]

Formal Education

Master of Science in Recording Arts emphasis in Media Forensics, University of Colorado Denver (currently enrolled, anticipated graduation in December 2019)

Bachelor of Science Degree, University of Miami, major of Electrical Engineering (Audio Engineering Program)

Additional undergraduate courses at the University of Florida

Work and Testimony Experience

Have conducted examinations on over 3,600 separate audio and video recordings and digital still images in over 1,280 criminal, civil, and administrative matters, which include submissions from 46 states, the District of Columbia, Australia, Brazil, Canada, Chile, Colombia, Croatia, Hong Kong, India, Indonesia, Republic of Ireland, Israel, Italy, the Netherlands, Puerto Rico, Romania, Singapore, Turkey, United Kingdom, and U.S. Virgin Islands.

Have testified as an expert in the fields of audio intelligibility enhancement, video enhancement, audio and video authenticity, signal analysis, and voice comparison/speaker recognition in federal and state courts and depositions in Arizona, California, Connecticut, Delaware, Florida, Illinois, Maryland, Minnesota, Mississippi, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Virginia, Washington, D.C., West Virginia, and in front of the Ukrainian Parliament.

Have conducted forensic examinations in numerous significant investigations/cases, including: the data recovery and intelligibility enhancement of the cockpit voice recording from United Airlines Flight 93, which crashed in Shanksville, PA on September 11, 2001; the authenticity analysis of the Linda Tripp/Monica Lewinsky telephone recordings involving the investigation of President William J. Clinton; the analysis of digital recordings related to the Washington D.C.-area sniper shootings; the authenticity examination of digital audio recordings from the office of former Ukrainian President Leonid Kuchma; the audio and image enhancement analyses plus transcription preparation in the Duke University Lacrosse Team case; the authenticity analysis of audio microcassette recordings in the Canadian Prime Minister Stephen Harper vs. The Liberal Party of Canada civil case; the authenticity examination of recordings surrounding the Texaco obstruction of justice investigation; and the authenticity examination of a recording related to the Abner Louima police brutality investigation.

Specialized Short Courses and Professional Training

ABCs of Video & Digital Technology, presented by the Sony Training Institute, in Lanham, MD

Advanced Forensic Audio Processing Techniques, presented by Digital Audio Corporation, Inc., in Raleigh, NC

Forensic Image and Video Enhancement with Amped FIVE, presented by Amped Software, Inc., in Stafford, VA

Specialized Short Courses and Professional Training (continued)

FBIRD Training, presented by Adaptive Digital Systems, Inc., in Quantico, VA

FBIRD Training (Personalized Instruction), presented by Adaptive Digital Systems Inc., in Irvine, CA

Fast Fourier Analysis, presented by Signal Processing Systems, in San Diego, CA

File Systems Revealed, presented by X-Ways Software Technology AG, in Seattle, WA

Forensic Audio Filtering and Tape Enhancement, presented by Digital Audio Corporation, Inc., in Quantico, VA

Forensic Authentication of Digital Audio, presented by the National Center for Media Forensics, University of Colorado, Denver, CO

Forensic Authentication of Digital Images, presented by the National Center for Media Forensics, University of Colorado, Denver, CO

Forensic Image and Video Processing, presented at the American Academy of Forensic Sciences, in San Antonio, TX

Forensic Image Processing, presented at the American Academy of Forensic Sciences, in Seattle, WA

Forensic Multimedia Authentication: Real Life Challenges and Solutions, presented at the American Academy of Forensic Sciences, in Baltimore, MD

Image and Video Processing Using MATLAB, presented by MathWorks, in Vienna, VA

Innovation in Forensic Image and Video Analysis, presented at the American Academy of Forensic Sciences, in Atlanta, GA

New Professional Core Curriculum Training Program, Phases I and II, presented by the Federal Bureau of Investigation, in Quantico, VA

Principles of Acoustics and the Measurement of Sound, presented by Brüel & Kjær, in Livonia, MI

Principles of Vibration Measurement and Analysis, presented by Brüel & Kjær, in Livonia, MI

R-DAT Format Training, presented by Sony Corporation, in Quantico, VA

Signal and Image Processing and Analysis for Scientists and Engineers, presented by Applied Technology Institute, in Laurel, MD

Spectrum Analysis of Sound & Vibration, presented by Brüel & Kjær, in Livonia, MI

Technical Recovery of Electronic Evidence, presented by Computer Security Institute, in Rancho Cucamonga, CA

Video Analyst System Training, presented by Intergraph, in Huntsville, AL

Specialized Short Courses and Professional Training (continued)

Video Capture, Enhancement and Analysis, presented by The Institute for Forensic Imaging (in association with Indiana University and Purdue University), Indianapolis, IN

X-Ways Forensics, presented by X-Ways Software Technology AG, in Seattle, WA

Peer-Reviewed Publications

1. Koenig, Bruce E.; Lacey, Douglas S. Forensic Authenticity Analyses of the Metadata in Re-Encoded M4A iPhone iOS 12.1.2 Voice Memos Files. *2019 Audio Engineering Society International Conference on Audio Forensics 2019*.
2. Koenig, Bruce E.; Lacey, Douglas S. Forensic Authenticity Analyses of the Metadata in Re-Encoded iPhone M4A Files. *2017 Audio Engineering Society International Conference on Audio Forensics 2017*.
3. Smith, Jeff M.; Lacey, Douglas S.; Koenig, Bruce E.; Grigoras, Catalin. Triage Approach for the Forensic Analysis of Apple iOS Audio Files Recorded Using the “Voice Memos” App. *2017 Audio Engineering Society International Conference on Audio Forensics 2017*.
4. Koenig, Bruce E.; Lacey, Douglas S. “Forensic Authentication of Digital Audio and Video Files.” *Handbook of Digital Forensics of Multimedia Data and Devices*. Ed. Anthony T. S. Ho. Ed. Shujun Li. Chichester: John Wiley & Sons, Ltd. **2015**. 133-181. Print.
5. Koenig, Bruce E.; Lacey, Douglas S. The Average Direct Current Offset Values for Small Digital Audio Recorders in an Acoustically Consistent Environment. *Journal of Forensic Sciences 2014*, 59(4), pp 960-966.
6. Lacey, Douglas S; Koenig, Bruce E. The Effect of Sample Length on Cross-Correlation Comparisons of Recorded Gunshot Sounds. *The Proceedings of the AES 54th International Conference on Audio Forensics 2014*, pp 122-129.
7. Koenig, Bruce E.; Lacey, Douglas S. Forensic Authenticity Analyses of the Metadata in Re-Encoded WAV Files. *The Proceedings of the AES 54th International Conference on Audio Forensics 2014*, pp 77-84.
8. Koenig, Bruce E.; Lacey, Douglas S.; Reimond, Christina E. Selected Characteristics of MP3 Files Re-Encoded With Audio Editing Software. *Journal of Forensic Identification 2014*, 64(3), pp 304-321.
9. Koenig, Bruce E.; Lacey, Douglas S.; Grigoras, Catalin; Price, Suzana Galić; Smith, Jeff M. Evaluation of the Average DC Offset Values for Nine Small Digital Audio Recorders. *Journal of the Audio Engineering Society 2013*, 61(6), pp 439-448.
10. Koenig, Bruce E.; Lacey, Douglas S. Forensic Authenticity Analyses of the Header Data in Re-Encoded WMA Files From Small Olympus Audio Recorders. *Journal of the Audio Engineering Society 2012*, 60(4), pp 255-265.
11. Koenig, Bruce E.; Lacey, Douglas S.; Richards, Gerald B. Video Frame Comparisons in Digital Video Authenticity Analyses. *Journal of Forensic Identification 2012*, 62(2), pp 165-182; 62(3), p 89.
12. Lacey, Douglas S.; Koenig, Bruce E. Identification of Identical and Nearly-Identical Frames from a Lawmate PV-500 Digital Video-Audio Recorder. *Journal of Forensic Identification 2012*, 62(1), pp 36-46.

Peer-Reviewed Publications (continued)

13. Koenig, Bruce E.; Lacey, Douglas S. An Inconclusive Digital Audio Authenticity Examination: A Unique Case. *Journal of Forensic Sciences* **2012**, 57(1), pp 239-245.
14. Lacey, Douglas S.; Koenig, Bruce E. Audio Extraction from Silicor Technologies' Digital Video Recorder File Format. *Journal of Forensic Identification* **2010**, 60(5), pp 573-588.
15. Koenig, Bruce E.; Lacey, Douglas S. Evaluation of Clipped-Sample Restoration Software. *Forensic Science Communications* **2010**, 12(2). [LINK](#)
16. Koenig, Bruce E.; Lacey, Douglas S. Forensic Authentication of Digital Audio Recordings. *Journal of the Audio Engineering Society* **2009**, 57(9), pp 662-695.
17. Koenig, Bruce E.; Lacey, Douglas S. Distinctiveness of Non-Standard VHS Head Parameters. *Journal of Forensic Identification* **2009**, 59(1), pp 97-126.
18. Lacey, Douglas S.; Koenig, Bruce E. Identification of an Eccentricity in the Date/Time Metadata of a PAL MiniDV Recording. *Journal of Forensic Sciences* **2008**, 53(6), pp 1417-1423.
19. Koenig, Bruce E.; Lacey, Douglas S.; Killion, Steven A. A Digital System for Imaging Bitter Patterns. *Journal of Forensic Identification* **2008**, 58(2), pp 238-264; 58(3), pp 281-282.
20. Koenig, Bruce E.; Lacey, Douglas S. Audio Record and Playback Characteristics of Small Solid-State Recorders. *Journal of Forensic Identification* **2007**, 57(4), pp 582-598.
21. Koenig, Bruce E.; Lacey, Douglas S.; Killion, Steven A. Forensic Enhancement of Digital Audio Recordings. *Journal of the Audio Engineering Society* **2007**, 55(5), pp 352-371.
22. Koenig, Bruce E.; Lacey, Douglas S.; Herold, N. Video and Audio Characteristics in VHS Over-Recordings. *Forensic Science Communications* **2006**, 8(3). [LINK](#)
23. Lacey, D. S. Burning Digital Audio Files to Standard Audio Compact Discs: More Than Drag and Drop. *NATIA News*. Summer 2005.
24. Koenig, Bruce E.; Lacey, Douglas S.; Killion, S. A. Analysis of the Radio Shack Micro-30 and the Olympus Pearlcoder S950 Time Code. *Journal of Forensic Identification* **2004**, 54(4), pp 442-451. Authors' Response to Letter. *Journal of Forensic Identification* **2004**, 54(6), pp 629-632.
25. Koenig, Bruce E.; Lacey, Douglas S.; Herold, Noel. Equipping the Modern Audio-Video Forensic Laboratory. *Forensic Science Communications* **2003**, 5(2). [LINK](#)

Other Publication

26. Baker, David W.; Brothers, Samuel I.; Geraarts, Zeno J.; Lacey, Douglas S.; Nance, Kara L.; Ryan, Daniel J.; et al. Digital evolution: history, challenges and future directions for the digital and multimedia sciences section. In: Ubelaker, Douglas H.; editor. *Forensic Science: Current Issues, Future Directions*. Chichester, UK: Wiley-Blackwell, **2013**, pp 252-91. [Contributing author]

Testimony

1. 05/09/2019; Stafford, VA; Deposition (miscellaneous video) [Case # 2018-09795; Circuit Court of Fairfax County];
2. 12/20/2018; Washington, D.C.; Deposition (voice comparison) [Case # 2:17-cv-0169-AB; US District Court for the Eastern District of Pennsylvania];
3. 12/07/2018; Hartford, CT; Deposition (video/audio authenticity) [Case # 16-CV-1564(WWE); US District Court for the District of Connecticut];
4. 11/01/2018; Fairfax, VA; Criminal Trial (video enhancement) [Case # FE-2018-0000970; Circuit Court of Fairfax County];
5. 10/09/2018; Upper Marlboro, MD; Criminal Trial (video enhancement) [Case # CT180097X & CT180021X; Prince George's County Circuit Court];
6. 06/19/2018; Richmond, VA; Criminal Trial (video enhancement & signal analysis) [Case # CR17F03896-00+; Richmond Circuit Court];
7. 10/23/2017; Washington, D.C.; Criminal Trial (video enhancement, miscellaneous video, & image analysis) [Case # 17 CF3 6228; Superior Court of the District of Columbia];
8. 09/22/2017; West Palm Beach, FL (via telephone from Fredericksburg, VA); Deposition (video enhancement) [Case # 2:16cv14413; US District Court for the Southern District of Florida];
9. 04/07/2016; Harrisonburg, VA; Criminal Trial (video authenticity & miscellaneous video) [Case # CR15000247-00; Rockingham County Circuit Court];
10. 02/08/2016; Boca Raton, FL (via video teleconference from Alexandria, VA); Deposition (audio enhancement) [Case # 50 2013 CA 013276 MB AJ; Circuit Court for Palm Beach County];
11. 10/30/2015; White Plains, NY; Deposition (miscellaneous video) [Case # 08 Civ. 4903 (KTD) (JM); US District Court for the Southern District of New York];
12. 09/29/2015; Lancaster, OH (via telephone from Stafford, VA); Deposition (video authenticity) [Case # 14CV 736; Court of Common Pleas, Fairfield County, Ohio];
13. 08/04/2015; Stafford, VA; Civil Trial (audio & video authenticity) [Case # JA035448-01-00, et al.; Stafford County Juvenile and Domestic Relations District Court];
14. 08/19/2014; Hohenwald, TN; Criminal Trial (audio authenticity) [Case # 2012-CR-6; Circuit Court of Lewis County];
15. 07/22/2014; Franklin, TN; Criminal Hearing (audio authenticity) [Case # 2012-CR-6; Circuit Court of Lewis County];
16. 11/19/2013; Stafford, VA; Criminal Trial (miscellaneous video) [Case # GC13014487-0; General District Court];
17. 01/17/2013; Baltimore, MD; Civil Trial (video enhancement and miscellaneous video) [Case # 1:11-cv-01399-WMN; Federal District Court];
18. 01/11/2013; Richmond, VA; Civil Trial (videotaped testimony) (miscellaneous video and video enhancement) [Case # CL08-000389; Circuit Court of the County of Gloucester];
19. 12/19/2012; Richmond, VA; Deposition (miscellaneous video and video enhancement) [Case # CL08-000389; Circuit Court of the County of Gloucester];
20. 12/17/2012; St. Paul, MN (via telephone from Clifton, VA); Deposition (signal analysis) [Case # 3494960; State of Minnesota Office of Administrative Hearings, Workers' Compensation Division];
21. 11/28/2012; Wilmington, DE; Criminal Hearing (audio authenticity) [Case # 0104015882; Superior Court of the State of Delaware In and For New Castle County];
22. 03/26/2012; Baltimore, MD; Criminal Hearing (miscellaneous video) [Case # 109317007 & 109317008; Circuit Court for Baltimore City];
23. 12/21/2011; Chicago, IL; Civil Trial (miscellaneous video) [Case # 08 L 4878; Circuit Court of Cook County];
24. 10/26/2011; Los Angeles, CA; Deposition (miscellaneous audio) [Case # BC363201; Superior Court of California (deposition in Washington, D.C.)];

Testimony (continued)

25. 04/20/2011; Washington, D.C.; Criminal Trial (miscellaneous audio) [Case # 2010 DVM 002499; Superior Court of the District of Columbia];
26. 03/30/2011; Leesburg, VA; Civil Trial (video duplication and authenticity) [Case # CL00059123-00; Circuit Court of Loudon County];
27. 03/17/2011; Los Angeles, CA; Deposition (miscellaneous audio) [Case # BC363201; Superior Court of California (deposition in Naples, FL)];
28. 12/20/2010; Chicago, IL (via video teleconference from Herndon, VA); Deposition (video enhancement) [Case # 07L2399; Circuit Court of Cook County];
29. 12/13/2010; Charlotte, NC; Criminal Trial (audio enhancement and miscellaneous audio) [Case # 09CR260997, 09CR260999; Mecklenburg County District Court]
30. 12/03/2010; Minneapolis, MN; Criminal Hearing (miscellaneous video) [Case # 82-CR-09-7129; Hennepin County District Court];
31. 10/25-26/2010; Vicksburg, MS; Civil Hearing (audio authenticity) [Case # 05-0004; Chancery Court of Issaquena County];
32. 07/29/2010; Williamson, WV; Criminal Hearing (video authenticity) [Case # A10-F88, A10-F102; Circuit Court of Mingo County];
33. 11/02/2009; New York, NY; Criminal Trial (miscellaneous audio and voice comparison) [Case # 03-CR-987-DAB; Federal District Court];
34. 08/26/2009; Tucson, AZ; Criminal Trial (video enhancement) [Case # CR-20063636; Pima County Superior Court];
35. 05/20/2009; Staunton, VA; Civil Hearing (video authenticity and miscellaneous video) [Case # CL06-000002; Augusta County Circuit Court];
36. 01/27/2009; Providence, RI; Deposition (miscellaneous video) [Case # 06-5785; Providence County Superior Court];
37. 12/13/2007; Yorktown, VA; Criminal Hearing (audio authenticity) [Case # CR06R38229-01; York County-Poquoson Circuit Court];
38. 09/27/2007; Tucson, AZ (via telephone from Clifton, VA); Criminal Trial (video enhancement) [Case # CR-20063636; Pima County Superior Court];
39. 09/13/2007; New York, NY; Deposition (audio authenticity) [Case # 06-CV-1944; US District Court for the Eastern District of Pennsylvania];
40. 09/05/2007; Kingwood, WV; Criminal Trial (signal analysis and audio enhancement) [Case # 07-F-5; Preston County Circuit Court];
41. 01/08/2007; Washington, D.C.; Criminal Hearing (audio enhancement and signal analysis) [Case # 05-CR-00151; US District Court for the District of Columbia];
42. 09/15/2006; Kiev, Ukraine; Hearing in front of the Ukrainian Parliament (audio authenticity);
43. 11/04/2005; High Point, NC; Criminal Trial (audio enhancement) [Case # 05-CRS-23105; Guilford County Superior Court];
44. 10/11/2005; Portland, OR; Criminal Trial (audio authenticity) [Case # 9906-34654; Multnomah County Circuit Court];
45. 02/23/2005; Roanoke, VA; Criminal Hearing (audio authenticity) [Case # 7:03CR00049-4; US District Court for the Western District of Virginia];
46. 02/04/2005; New York, NY; Deposition (audio enhancement) [Case # 99-CV-862-K(J); US District Court for the Northern District of Oklahoma];
47. 10/09/2001; Houston, TX; Criminal Trial (audio enhancement) [Case # 0845174; 176th District Court of Harris County];
48. 10/07/2001; Houston, TX; Criminal Hearing (audio enhancement) [Case # 0845174; 176th District Court of Harris County]; and
49. 05/13-14/2001; Philadelphia, PA; Criminal Hearing (audio enhancement) [Case # CR 01-88; US District Court for the Eastern District of Pennsylvania].

Presentations

American Academy of Forensic Sciences (AAFS):

- “An Analysis of Apple® iOS® Version Effects on Format and Metadata Structure of Audio Files Recorded Using the Native ‘Voice Memos’ App” [co-presenter] (2017)
- “Conversion of AVI ‘txts’ Stream Data to Adobe® Premiere Pro® Title Files” (2011) [awarded the Outstanding Case Study Award for the Digital & Multimedia Sciences section]
- “Considerations for the Forensic Authentication of Digital Audio Recordings” (2008)
- “Analysis of MiniDV Recording Date/Time Information” (2007)

Audio Engineering Society (AES):

- “Forensic Authenticity Analyses of the Metadata in Re-Encoded M4A iPhone iOS 12.1.2 Voice Memos Files” (AES International Conference on Audio Forensics, 2019)
- “Triage Approach for the Forensic Analysis of Apple iOS Audio Files Recorded Using the ‘Voice Memos’ App” [co-presenter] (AES International Conference on Audio Forensics, 2017)
- “The Effect of Sample Length on Cross-Correlation Comparisons of Recorded Gunshot Sounds” (AES 54th International Conference on Audio Forensics, 2014)
- “Forensic Digital Data Analysis” (AES 133rd Convention, 2012)
- “WinHex for Forensic Audio Analysis – Introduction, Applications, and Scripting” (AES 46th International Conference, 2012)
- “Considerations for the Forensic Authentication of Digital Audio Recordings” (Washington DC Section, 2007)
- Overview of the forensic audio field (University of Miami chapter)

International Association for Identification (IAI) – “Audio Extraction from Silicor Technologies, Inc.’s Digital Video Recorder Format” (2009)

National Technical Investigators Association (NATIA):

- “Bits and Bytes: Audio and Video File Analysis” (2013)
- “Authentication of Forensic Audio Recordings: Practices and Considerations” (2004)

NACDL and Cardozo School of Law National Forensic College (NFC) – “Considerations with Digital Audio, Video, and Image Evidence” (2017)

Private Investigators Association of Virginia – “Benefits & Limitations of Forensic Audio, Video, & Image Examinations” (2016)

Scientific Working Group on Digital Evidence (SWGDE) – overview of forensic audio enhancement tools

Various presentations to FBI personnel and Department of Justice personnel.

Professional Associations, Seminars, & Activities

Organization of Scientific Area Committees (OSAC)

- Executive Secretary (2017 – present) of the Digital/Multimedia Scientific Area Committee (SAC)
- Member (2016 – present) of the Digital/Multimedia SAC
- Member (2014 – present) of the Audio Forensics Task Group within the Digital Evidence Subcommittee of the Digital/Multimedia SAC
- Member (2014 – 2016) & Affiliate Member (2016) of the Video/Imaging Technology and Analysis Subcommittee within the Digital/Multimedia SAC

American Academy of Forensic Sciences (AAFS) [Fellow, 2006 – present]

- Director of the Digital & Multimedia Sciences section (2016 – 2019)
- Chair of the Digital & Multimedia Sciences section (2012 – 2014)
- Secretary of the Digital & Multimedia Sciences section (2010 – 2012)
- Digital & Multimedia Sciences section Program Committee member (2013 – 2014)
- Digital & Multimedia Sciences section By-Laws Committee member (2009 – 2010)
- Content Digitization (ad hoc) (2018 – present)
- Membership Outreach (ad hoc) (2019 – present)
- AAFS Nominating Committee (2014 – 2015)
- AAFS Membership Committee member (2010 – 2014)
- AAFS Continuing Education Committee member (2010 – 2014)
- AAFS Mentoring Committee (ad hoc) (2015 – 2016)
- Member of the Editorial Board for the *Journal of Forensic Sciences* (2015 – 2020)
- Guest Reviewer for the *Journal of Forensic Sciences* (2008 – 2010)

International Association for Identification (IAI) [Active Member, 2004 – present]

- Member of the Editorial Board for the *Journal of Forensic Identification* (2011 – present)
- Former member of the IAI's Forensic Video Analysis Certification Study Committee

Scientific Working Group on Digital Evidence (SWGDE) [Member, 2016 – present]

- Member of the Audio Committee

Audio Engineering Society (AES) [Member, 1997 – present]

- Member of the Technical Committee on Audio Forensics
- Papers Co-Chair for the *2019 AES International Conference on Audio Forensics* (Porto, Portugal)
- Papers Co-Chair for the *2017 AES International Conference on Audio Forensics* (Arlington, VA)

National Technical Investigators Association (NATIA) [Former member]

Have attended seminars and conferences of the AES, the IAI, the AAFS, OSAC, SWGDE, NATIA, and a regional meeting of the Acoustical Society of America. Invited exam developer for the (ISC)² Certified Cyber Forensics Professional (CCFPSM) certification program.